

## SPECIFICATION

### Title of the Invention

#### ABRASIVE SLURRY HAVING HIGH DISPERSION STABILITY AND MANUFACTURING METHOD FOR A SUBSTRATE

##### 1. Field of the Invention

[0001]

The present invention relates to an abrasive slurry having high dispersion stability. In particular, the invention relates to an abrasive slurry suitably applied to chemical mechanical polishing (hereinafter, referred to as CMP), although its application is not particularly limited thereto. CMP is widely employed for polishing a surface to be polished of photomask blanks, a glass disk, an optical lens, etc., as well as surface-polishing for leveling a substrate surface in a semiconductor manufacturing process or an electrostatic chuck manufacturing process.

##### 2. Description of the Related Art

[0002]

A substrate such as a silicon substrate used in a semiconductor manufacturing process or an aluminum substrate used in an electrostatic chuck manufacturing process needs to be leveled at

an extremely high precision, for instance. As a technique of leveling the substrate surface as a surface to be polished, a leveling technique is adopted, with which the substrate surface is leveled at a high precision without any damage by CMP that combines mechanical-polishing with chemical-polishing. Abrasive fine particles are used for mechanical-polishing and an etchant is used for chemical-polishing.

[0003]

In general, as an abrasive used in the above leveling technique, slurry is used, which is prepared by dispersing various kinds of abrasive fine particles into a dispersion medium such as water. Examples of such abrasive fine particles include: metal oxides such as cerium oxide ( $\text{CeO}_2$ ) and manganese dioxide ( $\text{MnO}_2$ ); silicon oxides ( $\text{SiO}_2$ ) such as a precipitated silica, a fumed silica, and a colloidal silica; aluminum oxides ( $\text{Al}_2\text{O}_3$ ) such as a fumed alumina and a colloidal alumina. Those particles having different sizes (average particle sizes) are appropriately selected according to a type of the substrate to be polished or a requisite process speed in the leveling technique.

[0004]

Accordingly, those abrasive fine particles show poor dispersion stability in the dispersion medium depending on their types or sizes. To give cerium oxide particles as an example, the particles each have a relatively large specific gravity. Thus, when dispersed into the dispersion medium to prepare an abrasive slurry,

the cerium oxide fine particles are uniformly dispersed for a while after the preparation but begin to separate not long afterward and precipitate, and finally aggregate together, resulting in the large particle size and wide particle size distribution. Thus, there arises a problem of the precipitation/aggregation. As a result, the process speed changes with time and the substrate surface is damaged, for example.

[0005]

Up to now, with a view to solving the above problem of the precipitation/aggregation of the abrasive slurry, there have adopted such treatment as redispersion treatment in which the abrasive slurry is stirred just before the use to redisperse the abrasive fine particles or separation/removal treatment in which abnormal aggregate-particles having a particle size larger than a predetermined size as a result of aggregation, are filtered, and separated and removed therefrom. Such the treatments place a heavy burden on the leveling process for the substrate or the like.

[0006]

Here, up to now, some proposals have been also made for solving the above problem of the precipitation/aggregation of the abrasive slurry.

That is, a cerium oxide abrasive has been proposed (see JP 2000-17,195 A). The cerium oxide abrasive contains cerium oxide fine particles, an ammonium acrylate-methyl acrylate copolymer,

and water and hardly precipitates, and can polish a surface to be polished of an  $\text{SiO}_2$  insulating film or the like at high speed without any damage.

[0007]

Also, another cerium oxide abrasive has been proposed (see JP 2001-138,214 A). The cerium oxide abrasive contains at least one compound selected from the group consisting of a water-soluble organic polymer, a water-soluble anionic surfactant, a water-soluble nonionic surfactant, and a water-soluble amine as a dispersant. The abrasive involves less precipitation with a maximum precipitation rate of  $1\mu\text{m/s}$  or less and enables the uniform dispersion with ease through stirring. The abrasive can polish a surface to be polished of an  $\text{SiO}_2$  insulating film or the like at high speed without any damage.

[0008]

Further, another cerium oxide abrasive has been proposed (see JP 2002-353,175 A). The cerium oxide abrasive contains: a first polyacrylate obtained by neutralizing more than 90% of the total of carboxyl groups in polyacrylic acid with ammonia; a second polyacrylate obtained by neutralizing 15 to 50% of the total of carboxyl groups in polyacrylic acid with ammonia; and water. The total content of the first polyacrylate and the second polyacrylate in the abrasive is 0.15 to 1 wt%. The abrasive shows a high stability and causes neither two-layer separation nor

aggregation/precipitation/solidification, nor viscosity change.

[0009]

However, those cerium oxide abrasives containing the dispersant are hardly kept in a sufficiently redispersed condition over 1 month or longer while causing no precipitation/aggregation for such a long term. Also, in the manufacturing process, there is a case where a pipe of an apparatus is clogged with the aggregated abrasive or the like. With those abrasives, such problems are not always solved completely and the problems still remain to be solved.

[0010]

Also, those cerium oxide abrasives each contain a relatively large amount (0.1 to 5 wt%) of organic compound such as the water-soluble organic polymer, the water-soluble anionic surfactant, the water-soluble nonionic surfactant, and the water-soluble amine as the dispersant. A waste liquid after polishing contains inorganic substances constituting the cerium oxide particles and organic substances constituting the dispersant in a mixed form. As a result, a problem arises in that waste liquid disposal requires a great deal of time and effort, and cost.

[0011]

In addition, in view of reducing costs for producing or transporting the abrasive slurry as much as possible, it is desirable that the slurry be produced at as high a concentration as possible during the production, and diluted to a given concentration when

in use. The higher the concentration, the more easily the precipitation/aggregation occurs. Therefore, there is a demand for development of the abrasive slurry having much superior dispersion stability.

#### SUMMARY OF THE INVENTION

[0012]

In view of the above, the inventors of the present invention have made extensive studies on an abrasive slurry keeping high dispersion stability for a long time and showing a satisfactory redispersion property, which can eliminate a problem about precipitation/aggregation as much as possible and can be used as a dispersant-free abrasive containing absolutely no organic dispersant. As a result, the inventors of the present invention have found that the addition of colloidal fine particles suppresses the precipitation/aggregation of the abrasive fine particles as much as possible. The colloidal fine particles include colloidal oxides and have an average particle size smaller than that of the abrasive fine particles. Thus, the present invention has been completed.

[0013]

Accordingly, an object of the present invention is to provide an abrasive slurry keeping high dispersion stability for a long time and showing a satisfactory redispersion property, which can

eliminate a problem about precipitation/aggregation as much as possible and can be used as a dispersant-free abrasive containing absolutely no organic dispersant.

[0014]

Another object of the present invention is to provide a manufacturing method for a substrate. The method is utilized for manufacturing a substrate such as a silicon substrate used in a semiconductor manufacturing process or an aluminum substrate used in an electrostatic chuck manufacturing process through CMP using the abrasive slurry with industrial advantage.

[0015]

More specifically, the present invention provides an abrasive slurry having high dispersion stability, including: abrasive fine particles made of one or more kinds of oxides; colloidal fine particles made of colloidal oxide with an average particle size smaller than an average particle size of the abrasive fine particles; and a dispersion medium in which the abrasive fine particles and the colloidal fine particles are dispersed.

Also, the present invention provides a manufacturing method for a substrate as an inorganic substrate, including a step for polishing the substrate by using the abrasive slurry.

[0016]

In the present invention, as the oxides used as the abrasive fine particles, oxides conventionally used as the abrasive fine

particles of this type may be adopted with no modification. Specific examples thereof include: metal oxides such as cerium oxide ( $\text{CeO}_2$ ) and manganese dioxide ( $\text{MnO}_2$ ); silicon oxides ( $\text{SiO}_2$ ) such as a precipitated silica, a fumed silica, and a colloidal silica; aluminum oxides ( $\text{Al}_2\text{O}_3$ ) such as a fumed alumina and a colloidal alumina. Those may be used singly or as a mixture of two or more.

[0017]

Among those oxides, preferably used as the abrasive fine particles in the present invention are the cerium oxide fine particles and the aluminum oxide fine particles, for example, which have a relatively large specific gravity or average particle size and easily precipitate/aggregate by themselves. Those are effectively applied particularly to the abrasive fine particles.

[0018]

An average particle size ( $D_p$ ) of the abrasive fine particles used in the present invention is not particularly limited to a specific value and varies depending on the kind thereof. In the case of the cerium oxide particles, the size is generally 100 to 5,000 nm, preferably 500 to 2,000 nm. Some kinds of abrasive fine particles cannot exert a polishing ability sufficiently with the average particle size ( $D_p$ ) below 100 nm. On the other hand, with the size above 5,000 nm, the surface to be polished is easily damaged.

[0019]

Further, the colloidal fine particles used together with the



abrasive fine particles may be colloidal oxides such as a colloidal silica and a colloidal alumina, for example. Those can be used singly or as a mixture of two or more.

[0020]

An average particle size ( $D_c$ ) of the colloidal fine particles should be at least smaller than the above size of the abrasive fine particles. Although varying depending on the kind thereof, in many cases including the case of using the colloidal silica, the average particle size is generally 10 to 300 nm, preferably 20 to 200 nm. A particle size ratio ( $D_c/D_p$ ) of the average particle size ( $D_c$ ) of the colloidal fine particles to the average particle size ( $D_p$ ) of the above abrasive fine particles is 10 or less, preferably about 0.01 to 3. If the average particle size ( $D_c$ ) of the colloidal fine particles is smaller than 10 nm, the particles are unstable and the abrasive easily gels during the production, whereas if the size is larger than 300 nm, the particle size variation is likely to occur. In addition, the particle size ratio ( $D_c/D_p$ ) is above 10, which results in too small abrasive fine particles. As a result, the polishing ability cannot be exerted sufficiently.

[0021]

Furthermore, as a dispersion medium constituting the abrasive slurry, a dispersion conventionally used in the abrasive slurry of this type may be used with no modification. The medium is not particularly limited to specific one but may be selected

appropriately according to applications of the abrasive slurry, the applications including: an abrasive slurry for CMP used for leveling a substrate such as a silicon substrate used in a semiconductor manufacturing process or an aluminum substrate used in an electrostatic chuck manufacturing process; an abrasive slurry for CMP used for polishing a surface to be polished of photomask blanks, a glass disk, an optical lens, or the like; and other generally-known abrasive slurry used for polishing a surface to be polished. However, preferably used is water or an aqueous dispersion medium. The aqueous dispersion medium contains water as a main ingredient, and a water-soluble solvent. Examples of the water-soluble solvent include: alcohols such as methanol, ethanol, n-propanol, iso-propanol, n-butanol, and tert-butanol; ketones; esters; and ethers. In the dispersion medium, as in the conventional case, an etchant is added for chemical polishing in CMP if necessary.

[0022]

A particle concentration ( $C_p$ ) of the above abrasive fine particles in the abrasive slurry of the present invention, although varying depending on the kind of the abrasive fine particles, is generally 5 to 40 wt%, preferably 5 to 30 wt%, more preferably 5 to 10 wt% in the case of the cerium oxide particles. In addition, a particle concentration ( $C_c$ ) of the colloidal fine particles in the slurry is generally 0.1 to 5 wt%, preferably 0.5 to 2 wt% in many cases including the case of using the colloidal silica. Further,

a weight distribution ratio ( $C_c/C_p$ ) of the colloidal fine particle concentration ( $C_c$ ) to the abrasive fine particle concentration ( $C_p$ ) is 1 or less, preferably 0.5 or less. The abrasive slurry prepared at the particle concentrations ( $C_p$ ) and ( $C_c$ ) are used for polishing such as CMP without changing the initial particle concentrations ( $C_p$ ) and ( $C_c$ ) or after being diluted to given particle concentrations ( $C_p$ ) and ( $C_c$ ). If the particle concentration ( $C_p$ ) of the abrasive fine particles is less than 5 wt%, the polishing ability is insufficient. In contrast, if the concentration is more than 40 wt%, a solubility is reduced. Also, with the particle concentration ( $C_c$ ) of the colloidal fine particles below 0.1 wt%, an effect of suppressing the precipitation/aggregation is reduced, whereas with the concentration ( $C_c$ ) above 5 wt%, the aggregation phenomenon is likely to occur. Also if the weight distribution ratio ( $C_c/C_p$ ) of the colloidal fine particle concentration ( $C_c$ ) to the abrasive fine particle concentration ( $C_p$ ) exceeds 1, the aggregation phenomenon is likely to occur.

[0023]

The abrasive slurry according to the present invention keeps high dispersion stability for a long time even if the organic dispersant such as the water-soluble organic polymer, the water-soluble anionic surfactant, the water-soluble nonionic surfactant, or the water-soluble amine is not particularly added thereinto. Further, the slurry has a satisfactory redispersion

property and can eliminate the problem about the precipitation/aggregation as much as possible.

[0024]

Also, in the present invention, any method of preparing the abrasive slurry may be adopted with no particular limitation as far as the abrasive fine particles, the colloidal fine particles, and the dispersion medium constituting the slurry are uniformly mixed and the slurry is prepared in which the abrasive fine particles and the colloidal fine particles are uniformly dispersed into the dispersion medium. The slurry can be prepared by using a general stirrer and optionally, a wet disperser such as an ultrasonic disperser, a homogenizer, a ball mill, a vibrating ball mill, a planetary ball mill, or a medium stirring type mill.

[0025]

The abrasive slurry of the present invention is used for leveling the substrate such as the silicon substrate used in the semiconductor manufacturing process or the aluminum substrate used in the electrostatic chuck manufacturing process. In addition, the slurry is used for polishing: an oxide film such as a silicon oxide insulating film formed on a wiring board having predetermined wirings; an inorganic insulating film made of glass, silicon nitride, or the like; optical glass for a photomask, a lens, a prism, or the like; an inorganic conductive film made of ITO or the like; an optical integrated circuit, an optical switching element, and

an optical waveguide constituted of glass and a crystalline material; an optical fiber end surface; an optical single crystal such as a scintillator; a solid-laser single crystal; a blue laser LED sapphire substrate; a semiconductor single crystal such as SiC, GaP, or GaAs; a glass substrate for a magnetic disk; or a magnetic head, for example.

[0026]

For example, consider a case of conducting CMP on a half-manufactured semiconductor substrate on which a circuit element and an aluminum wiring are formed or a semiconductor substrate prepared by further forming an oxide film such as a silicon oxide insulating film on the above half-manufactured substrate, for leveling the oxide film surface to smooth out the unevennesses thereof. In this case, a general polishing apparatus equipped with a holder for holding the substrate and a rotating table attached with a polishing pad is used. The abrasive slurry of the present invention is supplied successively to the polishing pad in a given amount at a time by means of a pump etc., and thus the surface can be polished at a given rotation speed under a given pressure.

[0027]

The polished substrate is well washed in running water as in the general post-treatment, after which water droplets on the substrate are wiped off and the substrate is dried with a spin drier or the like.

The waste liquid discarded at the time of polishing the substrate is a dispersant-free liquid containing absolutely no organic dispersant, so that the waste liquid disposal can be performed much more economically than before.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0028]

Hereinafter, a preferred embodiment of the present invention will be described in detail based on examples and comparative examples.

[0029]

Examples 1 to 27

[Preparation of Colloidal Silica (20 nm)]

In a 1 m<sup>3</sup>-tank with jacket provided with a liquid distillation port, a liquid level controlling apparatus, and a stirrer, 32 kg of methylsilicate, 100 kg of methanol, and 768 kg of pure water were charged and mixed to prepare a liquid A.

Also, in a 3 m<sup>3</sup>-tank provided with a stirrer, 368 kg of methylsilicate, 100 kg of methanol, 1,840 g of pure water, and 12 kg of 28 wt%-ammonia water were charged and mixed to prepare a liquid B.

[0030]

Next, the tank containing the liquid A was steam-heated to distill off a mixture liquid of methanol and water. At the time

when the mixture liquid began to distill off of the liquid A, the liquid B was added to keep the liquid level of the liquid A at a predetermined level. After the liquid B was completely added thereinto, 240 kg of pure water was further added to keep the liquid level of the liquid A at the predetermined level, followed by the reaction.

After the reaction, a reaction product was taken out of the tank in which the liquid A was charged and analyzed. As a result, the product was a colloidal silica product (colloidal silica (20 nm)) having a silica content of 20 wt% and an average particle size of 20 nm.

[0031]

[Preparation of Colloidal Silica (70 nm)]

In a 3 m<sup>3</sup>-tank with jacket provided with a stirrer, 1,721.7 kg of methanol, 306.3 kg of pure water, and 88.4 kg of 28 wt%-ammonia water were charged and mixed. After that, a liquid temperature was adjusted to  $23 \pm 1$  C°. While keeping the liquid temperature at  $23 \pm 1$  C°, 404.4 kg of methylsilicate was added in 2 to 2.5 hours with stirring, followed by the reaction.

[0032]

After the reaction, a crude product of the resultant reaction mixture was transferred to a 1 m<sup>3</sup>-tank with jacket provided with a liquid distillation port, a liquid level controlling apparatus, and a stirrer, and the tank was steam-heated to distill off a mixture

liquid of methanol, water, and ammonia. At the time when the mixture liquid began to distill off of the tank, the remaining reaction mixture was added to keep the liquid level at a predetermined level. After the reaction mixture was wholly added thereinto, pure water was further added to keep the liquid level at the predetermined level until the liquid temperature in the tank reached 100 C°.

[0033]

When the liquid temperature reached 100 C°, heating was terminated to thereby offer an intermediate product. The product was cooled until the liquid temperature dropped to 70 C°. At that point, an appropriate amount of 28 wt%-ammonia water was added and further, stirred and mixed, taking the reaction product off of the tank.

The resultant reaction product was a colloidal silica product (colloidal silica (70 nm)) having a silica content of 30 wt% and an average particle size of 70 nm.

[0034]

[Preparation of Colloidal Silica (170 nm)]

In a 1.8 m<sup>3</sup>-tank with jacket provided with a stirrer, 885.1 kg of methanol, 63.1 g of pure water, and 113.25 kg of 28 wt%-ammonia water were charged and mixed. After that, a liquid temperature was adjusted to 23 ± 1 C°. While keeping the liquid temperature at 23 ± 1 C°, 171.1 kg of methylsilicate was added in 3 hours with stirring, followed by the reaction.



[0035]

After the reaction, a crude product of the resultant reaction mixture was transferred to a 1 m<sup>3</sup>-tank with jacket provided with a liquid distillation port, a liquid level controlling apparatus, and a stirrer, and the tank was steam-heated to distill off a mixture liquid of methanol, water, and ammonia. At the time when the mixture liquid began to distill off of the tank, the remaining reaction mixture was added to keep the liquid level at a predetermined level. After the reaction mixture was wholly added thereinto, pure water was further added to keep the liquid level at the predetermined level until the liquid temperature in the tank reached 100 C°.

[0036]

When the liquid temperature reached 100 C°, heating was terminated to thereby offer an intermediate product. The product was cooled until the liquid temperature dropped to 70 C°. At that point, an appropriate amount of 28 wt%-ammonia water was added and further, stirred and mixed, taking the reaction product off of the tank.

The resultant reaction product was a colloidal silica product (colloidal silica (170 nm)) having a silica content of 22 wt% and an average particle size of 170 nm.

[0037]

[Preparation of Abrasive Slurry]

Cerium oxide particles (trade name: TE-508, produced by SEIMI

CHEMICAL Co., Ltd.) having an average particle size of 1.1  $\mu\text{m}$  and a maximum particle size of 8  $\mu\text{m}$  were used as the abrasive fine particles. The three types of colloidal silica prepared above were used as the colloidal fine particles. The pure water was used as the dispersion medium. Those were mixed at a blending ratio shown in Table 1 and uniformly mixed by a stirrer, preparing abrasive slurry according to each of Examples 1 to 27.

[0038]

[Evaluation of Preparation/Aggregation Condition and Redispersiion Property]

An aliquot (50 ml) of the obtained abrasive slurry of each of Examples 1 to 27 was put in a 100 ml-test tube and left standing for 1 month. After that, a precipitation/aggregation condition thereof was visually observed.

Also, 50 ml of abrasive slurry was put in a 100 ml-polyethylene vessel and left standing for 1 month. Thereafter, a redispersiion property thereof was visually observed while shaking the vessel with hands. In addition, the vessel was laid and placed on a table ball mill stirrer (model: V-1M, manufactured by IRIE SHOKAI Co., Ltd.), followed by stirring under the stirring conditions of a rotation speed of 100 rpm and a time period of 10 minutes. Thus, the redispersiion property with the stirrer was visually observed.

[0039]

The precipitation/aggregation condition and the redispersiion

property were evaluated based on the following four criteria.

⊙: The whole precipitated portion was soft, which could be redispersed through shaking with hands for several seconds and redispersed through stirring with the stirrer for 5 or less minutes.

○: The precipitated portion was partially solidified, which took about 30 seconds to redisperse through shaking with hands and about 10 minutes to redisperse through stirring with the stirrer.

△: The precipitated portion was partially solidified, which took 2 or more minutes to redisperse through shaking with hands and about 10 minutes to redisperse through stirring with the stirrer.

×: The whole precipitated portion was solidified throughout, which could not be redispersed even through shaking with hands for 10 minutes and which took 10 or more minutes to redisperse through stirring with the stirrer.

The results are shown in Table 1.

[0040]

[Quartz Substrate Polishing Rate]

Further, the abrasive slurry was diluted three-fold with ultrapure water. A CMP polishing apparatus with a polishing pad (FACT-200, manufactured by Nanofactor K.K.) was used to polish a sample (quartz substrate measuring 3.3 cm x 2.6 cm in width and length with a thickness of 1.15 mm) for 10 minutes under the conditions that the rotation speed was 200 rpm, a process pressure was 500 g/cm<sup>2</sup>, and a supply rate of the abrasive slurry was 10 ml/min. The

thickness of the sample was measured with a micrometer before and after polishing, and a difference of the thickness between before and after polishing was obtained for calculating a polishing rate ( $\mu\text{m}/10\text{ min}$ ) with respect to the quartz substrate ( $\text{SiO}_2$ ).

The results are shown in Table 1.

[0041]

Comparative Examples 1 to 15

As an organic dispersant, polyvinylpyrrolidone (PVA) was used. Similarly to Examples 1 to 27 above, abrasive slurry of each of Comparative Examples 1 to 15 was prepared. The prepared abrasive slurry of each of Comparative Examples 1 to 15 was evaluated for the precipitation/aggregation condition and the redispersion property in the same way as in Examples 1 to 27 above. Further, the polishing rate ( $\mu\text{m}/10\text{ min}$ ) with respect to the quartz substrate ( $\text{SiO}_2$ ) was calculated.

The results are shown in Table 1 together with those of Examples 1 to 27 above.

[0042]

[Table 1]

Example No.		1	2	3	4	5	6	7	8	9
Composition of abrasive (wt%)	Cerium oxide particle ( $\text{CeO}_2$ )	5	15	30	5	15	30	5	15	30
	Colloidal silica (20 nm)	1	1	1	2	2	2	5	5	5
	Dispersant	-	-	-	-	-	-	-	-	-
Evaluation of precipitation/aggregation condition and redispersion property		◎	◎	◎	◎	◎	◎	◎	◎	◎

Quartz substrate polishing rate (three-fold diluent: μm/10 min)		10	10	10	10	10	10	10	10	10
Example No.		10	11	12	13	14	15	16	17	18
Composition of abrasive (wt%)	Cerium oxide particle (CeO <sub>2</sub> )	5	15	30	5	15	30	5	15	30
	Colloidal silica (70 nm)	1	1	1	2	2	2	5	5	5
	Dispersant	-	-	-	-	-	-	-	-	-
Evaluation of precipitation/aggregation condition and redispersion property		⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
Quartz substrate polishing rate (three-fold diluent: μm/10 min)		10	10	10	10	10	10	10	10	10
Example No.		19	20	21	22	23	24	25	26	27
Composition of abrasive (wt%)	Cerium oxide particle (CeO <sub>2</sub> )	5	15	30	5	15	30	5	15	30
	Colloidal silica (170 nm)	1	1	1	2	2	2	5	5	5
	Dispersant	-	-	-	-	-	-	-	-	-
Evaluation of precipitation/aggregation condition and redispersion property		⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
Quartz substrate polishing rate (three-fold diluent: μm/10 min)		10	10	10	10	10	10	10	10	10
Comparative Example No.		1	2	3	4	5	6	7	8	9
Composition of abrasive (wt%)	Cerium oxide particle (CeO <sub>2</sub> )	5	15	30	5	15	30	5	15	30
	Colloidal silica	-	-	-	-	-	-	-	-	-
	Dispersant	-	-	-	1	1	1	3	3	3
Evaluation of precipitation/aggregation condition and redispersion property		×	×	×	△	△	△	×	×	×
Quartz substrate polishing rate (three-fold diluent: μm/10 min)		-	-	-	10	10	10	10	10	10
Comparative Example No.		10	11	12	13	14	15			
Composition of abrasive (wt%)	Cerium oxide particle (CeO <sub>2</sub> )	5	15	30	5	15	30			
	Colloidal silica	-	-	-	-	-	-			
	Dispersant	1	1	1	3	3	3			
Evaluation of precipitation/aggregation condition and redispersion property		△	△	△	○	△	△			
Quartz substrate polishing rate (three-fold diluent: μm/10 min)		10	10	10	10	10	10			

[0043]

As apparent from the results shown in Table 1, the abrasive slurry according to each of Examples 1 to 27 of the present invention

exerted excellent properties in terms of the evaluation on the precipitation/aggregation condition and the redispersion property and the quartz substrate polishing rate. In contrast, the abrasive slurry of each of Comparative Examples 1 to 3, which was added with neither the colloidal fine particles nor the dispersant, could not be redispersed and the polishing rate thereof could not be measured. The abrasive slurry of each of Comparative Examples 4 to 15, which was added only with 1 wt% to 3 wt% of dispersant, took much time to redisperse. The results revealed that the abrasive slurry according to the present invention could have the superior property particularly in terms of the precipitation/aggregation condition and the redispersion property.

[0044]

According to the present invention, it is possible to provide the abrasive slurry keeping high dispersion stability for a long time and showing a satisfactory redispersion property, which can eliminate a problem about precipitation/aggregation as much as possible and can be used as a dispersant-free abrasive containing absolutely no organic dispersant.

Also, the abrasive slurry of the present invention is used, whereby it is possible to manufacture the substrate such as the silicon substrate used in the semiconductor manufacturing process or the aluminum substrate used in the electrostatic chuck manufacturing process through CMP with industrial advantage.